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A Review of

DATE INVESTIGATIONS at the U.S. Date Field Station, Indio, California

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A REVIEW OF DATE INVESTIGATIONS AT THE U. S. DATE FIELD STATION, INDIO, CALIFORNIA

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In 1904, the U.S. Department of Agriculture began an experimental date garden on leased land 2 miles east of Mecca in the Coachella Valley of California. This first station was established in cooperation with the California Agricultural Experiment Station, but from the beginning it was operated by the Federal Government. Three years later, because of the threatened flooding of the Mecca station by the rising waters of the newly formed Salton Sea, headquarters for experimental work were moved to a new location 2 miles west of Indio where 20 acres for this purpose was donated by Fred N. Johnson to the Federal Government. A little later the U.S. Department of Agriculture acquired 10 additional acres of adjacent land. However, about 5 acres is taken up by the Whitewater storm channel and 5 acres more by buildings, lawns, and roadways so that only about 20 acres is actually available for experimental plantings.

This second station, now known as the U.S. Date Field Station, has been the center for date research since its establishment, but some work was carried on at Mecca for about 25 years before it was discontinued. The U.S. Date Field Station has played an important part in the development of the date industry in the United States and through its research has greatly extended our scientific knowledge of the date palm and the conditions necessary for optimum fruit production (146).[1/]

This paper summarizes the accomplishments of the U.S. Date Field Station. The importance of the major contributions and the nature of other work are indicated so that the program may be understood and evaluated. Detailed information about all the subjects mentioned can be found in the literature cited.

In the literature list it has seemed desirable to include all the publications on dates by employees of the U.S. Department of Agriculture. Most of the research reported in this summary has been done at the U.S. Date Field Station or by members of the staff. Studies on storage and handling have been conducted by specialists in that field who have had their headquarters part of the time at the U.S. Date Field Station and part of the time elsewhere. Those directly charged with the administration of date research have, from the beginning, sought and encouraged the cooperation of other divisions of the Department of Agriculture in solving particular problems requiring special facilities and skills not available at the U.S. Date Field Station.

In the list of publications, an asterisk indicates a worker who has not at any time been connected with the Indio station. Research done entirely by workers not connected with the U.S. Department of Agriculture is not listed even though in some instances the projects were taken up at the

1/ Numbers in parentheses refer to Literature Cited, p. 14.

request or suggestion of the Department and date material was furnished by the U.S. Date Field Station.

EXPLORATION AND IMPORTATION

During the last half of the 19th century the fruiting of a few seedling date palms in various parts of the hot interior valleys of California and southern Arizona called attention to the possibilities for date culture in this region. This led the U.S. Department of Agriculture to send explorers to the date-growing countries of the Old World to study the conditions necessary for date culture and to import offshoots of the best varieties for trial in this country. Walter T. Swingle (183,184,199) went to Algeria for this purpose in 1899 and again in 1900. The second year he made the first successful importation of date offshoots of superior varieties including the Deglet Noor, already well known in European markets. His studies of climatic and soil conditions in southern Algeria, followed by similar studies in the arid Southwest, led to the establishment of a date experiment station in the Coachella Valley in 1904, as previously mentioned, and date investigations were conducted under his general supervision for three decades.

Swingle was followed by other explorers whose studies of dates were either inspired or directed by him. In 1901-02, David Fairchild (34) made experimental importations of offshoots of some of the best date varieties from Iraq, Baluchistan, and Egypt. In 1905, T. H. Kearney (52,53,54) obtained a collection of the best varieties from Tunisia. In 1913, 1920, and 1922, S. C. Mason (66,67,73) visited Egypt and obtained offshoots of Hayany, Saidy, and other leading varieties; he also cleared up confusion in regard to their nomenclature.

In 1927, Swingle (195,198,201) obtained from Morocco, 11 offshoots of the Medjool date, formerly the leading export variety of that country. These offshoots were planted and the variety propagated until sufficient offshoots were available for distribution. From 1944 to 1951, when the supply was exhausted, over 1,600 offshoots of the Medjool were distributed among date growers under cooperative agreements for testing in the Coachella, Imperial, Yuma, and Salt River Valleys. The fruit is now appearing on the market. The Medjool brings a premium because of its large size and attractive appearance and is increasing in favor as a choice dessert date.

In 1928-29, Roy W. Nixon studied date varieties in Iraq and made an importation of offshoots for testing in southwest Texas (87,204). Amir Hajj, one of the varieties introduced at that time, is a date of better-than-average quality and has shown considerable resistance to souring (114).

VARIETY STUDIES

Adaptation. In addition to the variety collections at the U.S. experiment stations, specimens of the more promising varieties available were furnished, over three decades, to date growers for testing in new localities in various parts of southern California and Arizona and to the Texas

Agricultural Experiment Stations at Weslaco and Winter Haven. Much valuable information about the behavior of the different varieties under varying conditions has been obtained from these tests; this has been incorporated in reports dealing with various phases of adaptation (92,99,103,114,116,131).

Identification and description. While the adaptation of varieties was being studied, a continuous effort was made to reduce confusion in nomenclature. In some instances the same variety was imported under several different names. In others, several different varieties were imported under the same name. It was apparent that inferior dates had been substituted for, or accidentally mixed with, better varieties and the identity of many varieties, even some of the best, was in doubt. This was more or less inevitable because very little study of varieties had previously been made in the Old World and little or no descriptive information was available for most of them. From studies of all the different dates imported, the number and character of the different varieties were finally determined. It was possible by subsequent investigations in the countries of origin to learn the identity of the more important varieties that had been imported under incorrect labels (64,66,67,73,74,93,107,114,120,121,126,127).

Although practically all date varieties are believed to have originated from seeds, the discovery of a few bud mutations has indicated the possibility of new types originating in this way (76,125,177).

Breeding. The possibilities for eventual improvement of the date industry by means of a breeding program have long been recognized. Every commercial date variety has some defect, such as, for example, the extreme sensitivity of the Deglet Noor fruit to damage from high humidity and very short fruit-stalks of the Medjool variety, which increase breakage and difficulty in handling the bunches. Also, better males are needed as most of those in use are miscellaneous seedlings lacking many desirable characters. Little has been done because of the time and space required for such a project and the pressure of more immediate problems that could be solved more quickly. A small start in breeding was made in 1940 but this had to be discontinued two years later because the experimental farm on which the planting was located was abandoned by the Indian Service which operated it. However, some of the palms were saved by transplanting to the Indio Station. One has proved to be a male of some promise as its pollen stimulates large size and fairly early ripening of the pollinated fruit (128).

The present date-breeding project is conducted cooperatively by the U.S. Southwestern Irrigation Field Station at Brawley, Calif., and the U.S. Date Field Station at Indio. In 1951, funds for date and citrus breeding were allotted to the Brawley Station, land was made available there for planting seedlings, and the superintendent of the U.S. Date Field Station was made a staff member of the Brawley Station and placed in charge of the cooperative breeding project of the two stations. Seeds of the best commercial date varieties and some others with certain desirable characters were planted at Brawley in 1951, 1953 and 1954. Beginning in 1959, experimental plantings have been made in cooperation with Brock Ranches on the East Mesa in Imperial Valley. By using males from the seedlings

for backcrosses on the female parent, it is believed that male strains that will increase the possibility of transmitting the desired characters through pollen may be developed. The final objective is to combine in one variety desirable characters now found in different varieties. This is obviously a long-term project for even after a new and better date is originated, many years are required to increase it by means of offshoots to the status of a commercial date. However, there should be advantages from the development of new and better males within a much shorter time for one good male may supply pollen for 100 or more fruiting palms (136).

POLLINATION

Duration of receptivity of female flowers. The length of time female flowers are receptive to pollen was determined by early experiments. It was shown that the longer pollination is delayed after the opening of the spathe the poorer the set and if more than a week elapses the yield is usually greatly reduced (56).

Direct effect of pollen on fruit. Investigations at the U.S. Date Field Station, supplemented by numerous tests in commercial date gardens, have proved that pollen not only influences the size and shape of the seed but also has a direct effect on the size and time of ripening of the fruit (26,81,82,83,84,85,86,88,90,94,95,98,128,129). This discovery has attracted widespread attention among botanists and horticulturists because it was the first conclusive proof of a direct effect of pollen on fruit outside the embryo and endosperm of the seed. A new name, metaxenia, was coined (194) for this phenomenon.

The maximum differences obtained by the use of different pollens have ranged from about 10 days when fruit ripens early in hot weather to as much as 2 months when fruit ripens late in cool weather. Practical use of this effect of pollen has been made by a few growers in localities where some Deglet Noor fruit sometimes does not ripen until February or March. When a pollen known to induce early ripening was selected for pollinating flower clusters in the latter part of the season, it has been possible to complete the harvest by the end of December. By proper selection of pollen, dates can undoubtedly be ripened in many localities where they have never reached maturity.

Storage of pollen. Dry pollen stored at ordinary room temperatures under desert conditions has been found to lose its viability before the next pollination season. The higher the temperature the more rapidly the pollen deteriorates (49). However, experiments have shown that pollen keptin a dry condition in cold storage may be held satisfactorily from one pollination season to the next (4,27,28). Many growers now store pollen from one year to the next for use early in the season when there is often not enough fresh pollen.

Pollen germination. Poor sets of fruit are sometimes associated with cold weather during the early part of the pollination season. Experiments have shown that by enclosing the flower cluster in a paper bag, set may be

materially improved when temperatures are low (150). Bagging of flower clusters early in the season is now practiced by some growers as an insurance against poor sets.

FRUIT THINNING

Experimental studies with the more important commercial varieties of dates have shown the relation of the amount and method of fruit thinning to size of fruit, time of ripening, and such quality factors as shrivel, checking, and blacknose (96,97,101,102,119,130,139,175). This information has provided a background for the evolution of methods of bunch thinning adapted to the peculiarities of the different varieties.

LEAF PRUNING

Studies of leaf pruning have been made along with fruit thinning. These studies indicate that the ratio of leaves to fruit cannot be lowered beyond a certain point without loss of quantity and quality of production; date palms under favorable growing conditions may acquire and retain more green leaves than are necessary for maximum fruit production; and at least in the Deglet Noor variety, an excess of leaves below the fruit bunches may result in lower quality by increasing checking, blacknose, and shrivel (100,104,112).

Subsequent investigations have resulted in a better understanding of the relation of age and position of date leaves to fruit production. Through the cooperation of the Citrus Experiment Station, it has been possible with some of its expensive technical equipment to make laboratory tests of the efficiency in photosynthesis of detached parts of date leaflets of different ages (143). In these tests the food-manufacturing ability of date leaves reached its maximum at about the time of full maturity (when the leaves were about a year old) and at the end of the second year it had begun to decline. At the end of the fourth year, it was only about 65 percent as efficient as it was in its prime. It is to be expected that these differences in leaf efficiency are reflected in fruit production but, as evaluated in the field, other experiments indicate that, apart from age, the position of the leaf is also important - that the closer the leaf is to the base of the fruitstalk the more value it is to the fruit on that bunch (132).

IRRIGATION STUDIES

The relation between irrigation and the growth and fruiting of date palms has been studied for many years. The effects of varying degrees of soil moisture deficiency as related to different dates, amounts, and frequencies of irrigation have been determined. It has been found that when any considerable proportion of soil in the principal root zone is in or near the wilting range of soil moisture for an appreciable length of time the rate of leaf growth is reduced. This growth rate is easily measured by attaching one end of a copper wire to a newly emerging but unexpanded leaf and checking its upward movement at intervals from the comparative position

of the lower end of the wire with reference to a fixed point, such as a spike driven into the palm trunk.

The extent to which the reduced leaf growth produced by moisture deficiency affects fruit production depends on its severity and on the time and duration of its occurrence. If leaf growth is reduced to 80 percent of normal or less for several weeks during late spring and early summer when the fruit is growing rapidly, the growth rate and ultimate size of the fruit, both fresh and dry weight, is reduced, grade lowered, and time of ripening hastened up to as much as 2 weeks. However, susceptibility to checking and blacknose is reduced. As fruit nears maturity the effect on its size becomes progressively less.

With palms in full production on a deep soil of high water-holding capacity it has been found that if ample soil moisture is provided up to the middle of July, subsequent irrigations may be greatly reduced or omitted for 2 or 3 months without reduction in yield or quality of fruit. Leaf growth may be reduced during this period but an acceleration of growth after normal irrigations are resumed compensates for this. Ripening may be slightly earlier but this is usually followed by some delay in flowering the following spring with the end result that, if the schedule is continued, there is not much difference in the time of ripening of fruit. However, long intervals between irrigation are not recommended because of difficulties in salt removal and soil management. The yearly requirements of both Khadrawy and Deglet Noor palms in full production have been found to be about 7 feet of water per year, but the application of an additional 2 or 3 feet per year is necessary to leach excess salts below the root zone (2,5,6,9,35,38,39,41,42,47,48,78,79,145,149,196).

These recommendations must be modified according to soil type. Frequent applications of water in excess of field capacity may be wasteful for palms in a deep soil of high moisture-holding capacity; but in a deep, coarse sandy soil of low moisture-holding capacity, palms of the Deglet Noor variety were greatly benefited - higher yield and better quality of fruit and better palm growth - by supplementary irrigation in excess of that usually considered normal (145).

In an experiment in which irrigation water remained on the soil for several days after its application, fluctuations in soil atmosphere (oxygen and carbon dioxide) were measured. In spite of considerable variation, there was no apparent injury to date palms in full production (36).

The occurrence of the disorders hard end, khalal shrivel, and immature shatter of the fruit of Halawy date palms was greatly increased by withholding irrigation so as to produce moderate drought in June and July, but there was little or no effect from similar drought in August and September. It was apparent that in addition to duration and severity of drought, the stage of fruit development at the time of drought and the other weather conditions accompanying it are important factors in the development of these disorders (43).

FERTILIZATION

Studies of the fertilizer requirements of date palms have been chiefly on nitrogen which, in most western soils, usually is the only major element needed by tree crops. Soils available for studies at the U.S. Date Field Station are mostly good, permeable sandy loams with some silt. On these soils, date palms have been slow to respond to applications of nitrogen. In one experiment, Deglet Noor palms not quite in full bearing at the beginning, were given relatively large annual applications of nitrogen - 6 pounds per palm the first 3 years and 8 pounds per palm the last 4 years. Growth and fruit production of the unfertilized palms were as good as those of the fertilized palms for the first 3 years but decline thereafter and during the last 4 years were about 20 percent less (48).

In a similar experiment with Khadrawy palms in full bearing, applications of 8 pounds of nitrogen per palm per year produced no significant increase in growth or fruit production during 5 years, but a cover crop of sweet clover grown on each plot each season may have supplied enough nitrogen for maximum fruit production (47). In other experiments there was little or no response to nitrogen applied to Deglet Noor palms during the first 7 years after planting, to Medjool palms during the first 5 years after planting, and to Medjool palms for 5 years after reaching full production (40,44). There is some evidence that large amounts of nitrogen (8 to 13 pounds per palm per year), which usually increase growth and production of older palms, may lower the quality of Deglet Noor fruit by producing an unattractive off-color in the natural grades and a high proportion of small, shrivelled, low-acid type fruit in the dry grades (41). All results indicate that the application of nitrogen, particularly large amounts, may be wasteful if made without respect to soil type or condition of palms.

A study of the nitrogen content of soils in date gardens as compared with virgin uncultivated soils nearby has shown that even after 30 years of cultivation there is very little difference except for a slight increase in the top foot. This incicates that relatively little nitrogen accumulates from continued applications and if the nitrogen is applied in advance of need much of it may be lost. Although the percentage of nitrogen in desert soils is low (less than 0.1 percent), the total amount in the top 8 feet is estimated at 2,000 to 15,000 pounds per acre. Therefore, a palm in good soil and with a well-distributed root system may not suffer from lack of nitrogen for many years. It has been estimated that an acre of dates in full bearing removes from the soil about 60 pounds of nitrogen per year (45).

Chemical analyses have provided information about the mineral constituents of date leaves and the changes that occur with age (75,147). In experiments with nitrogen fertilization it has been found that significant differences in fruit production are accompanied by differences in the nitrogen content of the leaves. This indicates that leaf analysis may prove useful in a study of the nitrogen needs of the date palm. Further data, however, are needed to establish standards of reference (46).

A study of the fertilizer value of date-leaf and fruitstalk prunings, which are chopped and returned to the soil by many growers, has shown that they add more organic matter than the average cover crop of yellow sweetclover but are low in nitrogen (0.5 percent). To prevent the loss of nitrogen during the decomposition of the organic matter, it was estimated that 58 pounds of nitrogen per acre should be added to supplement the prunings (4,800 pounds of dry matter) of an average date garden (33).

Observations and study have shown that the date palm tolerates more salt than most other tree crops but growth may be seriously reduced without the development of prominent symptoms and there is no question but that growth is better on soils of low salt content (32,50). In a survey of representative date gardens in Coachella Valley, Calif., it was found that salt tended to accumulate where the soil was of fine texture, where layers of clay or silt effectively limited drainage, where the water table was high, or where combinations of these conditions occurred (12).

OFFSHOOT HANDLING

Although it was early demonstrated that date offshoots detached from the palm can be rooted (31), subsequent experience has shown that the percentage of survival is higher and the cost of handling less if they are left on the palm until well rooted. In later experiments better growth and survival were obtained when the offshoots weighed more than 30 pounds after being cut and trimmed for transplanting. The removal of most of the offshoots from a palm increased the size and later growth of those left for another year or two before cutting and transplanting; also the removal of offshoots increased the subsequent growth and flowering of the parent palm. The most desirable frequency of irrigation of the transplanted offshoots was found to depend on soil type. In a previous fine sand or sandy loam, irrigation ever 2 or 3 days was most satisfactory for the first 40 days; in somewhat impervious soils, intervals of 7 to 14 days, according to the length of time water stood on the surface, proved better (8,51).

COVER CROPS

Preliminary tests have been made with several possible cover crops for date gardens but they have not been followed up because of lack of space and personnel and the pressure of other more important projects. Of the winter cover crops tried, the Hubam variety of sweetclover has given the best results. Of the summer cover crops, sesbania and sudangrass have produced most tonnage but the tepary bean has shown some promise (202).

DISEASES

Work on diseases of the date palm has not been attempted at the U.S. Date Field Station because pathological investigations have been conducted by the University of California Citrus Experiment Station from Riverside. However, the cause of one physiological disorder, checking and blacknose, was discovered and the conditions under which it occurs were determined.

It was found that checking occurs only during periods of high humidity at the time when the date fruit has almost reached full size, just before turning from green to the red or yellow of the khalal stage, which precedes final ripening (91). Later the physiological processes involved were studied. It was found that checking results when the loss of water by transpiration from the fruit is not sufficient to offset the influx of water into the fruit. When this occurs the cells at or near the surface of the fruit become enlarged and finally rupture as a result of high pressure. High atmospheric humidity reduces transpiration from the fruit and increases the movement into the fruit through conductive tissues by also reducing transpiration from the leaves. Excess soil moisture at this time supplies additional water to the fruit and increases the susceptibility to checking (7). An understanding of the conditions under which checking and blacknose occur makes possible the adaptation of beneficial cultural practices. The U.S. Date Field Station cooperates with the University of California in investigating any disorders that occur from time to time (30).

INSECTS

Parlatoria scale eradication. Parlatoria scale (Parlatoria blanchardi (Targ.)) was introduced with the first importations of date offshoots and was soon recognized as a serious pest. In 1913 the U.S. Department of Agriculture began a campaign of inspection and treatment. A method of defoliation and torching of infested palms previously worked out by the Arizona Agricultural Experiment Station was used. With the cooperation of the States of Arizona and California, this program, directed in later years by the Bureau of Entomology[2/] of the U.S. Department of Agriculture with headquarters at Indio, was finally successful in eradicating Parlatoria scale, generally regarded as the worst menace ever faced by the date industry in the United States (21,22,176).

Entomological investigations. Laboratory and field investigations of all insects found on the date palm in the United States have provided valuable information concerning their life history and methods of control (18,19,20, 179,180,181,182). From taxonomic studies it was found that the date mite that attacks fruit in the United States is a different species from the one that occurs in the Old World (58).

MATURATION, STORAGE, AND HANDLING

For various reasons it may be desirable or unavoidable to pick some dates at varying stages immediately before they are fully ripe and cured. One of the first problems investigated by the U.S. Department of Agriculture was how best to handle such dates to bring them to full maturity with optimum quality and to preserve it in storage. It was found that the best flavor and color of the Deglet Noor, the principal commercial variety, are obtained when the fruit is ripened and cured at a temperature of

2/ Now the Entomology Research Division, Agricultural Research Service.

95 degrees F. or less and that the keeping quality is prolonged if the fruit is placed in cold storage when still slightly immature, as indicated by the retention of a small portion of firm flesh ("rag") at the base. At 32 degrees F., with moisture content not over 25 percent, full ripened fruit will remain in good condition for 5 to 6 months but slightly immature fruit, as described, may be stored satisfactorily for 9 to 10 months (13, 178,186,190).

Early work and all subsequent investigations have emphasized that the most important single factor affecting keeping quality is the moisture content of the date. Dates with a moisture content higher than a certain critical point, about 25 percent for the Deglet Noor variety, are increasingly susceptible to deterioration as the moisture content increases, the temperature rises, or the storage is prolonged. Great variability of moisture content, often as much as 10 percent, among individual dates in a single container, is a common source of spoilage by the time the packaged dates reach the consumer. Some of the dates may become too dry in the course of time but more dangerous is that one date of high moisture content may spoil very quickly and render the entire package unacceptable. Even before the dates become unacceptable they deteriorate more rapidly above the critical moisture content by darkening of color and loss of flavor (15,168,169,170,172).

The correct humidity necessary in storage to maintain a given moisture content in the fruit has been determined (161,162). A practical method was devised for the rapid determination of the moisture content of dates with a portable hand refractometer (154,157). Investigations have shown the influence of handling procedures and storage and transit temperatures on fruit quality (171). Information has been obtained about the effect on the fruit of different methods and conditions of hydration, and a technique was worked out for improving the appearance of such dates by adding a glaze or attractive luster to the skin (16,156). It was discovered that sugar spotting of dates in storage is most likely to occur when the moisture content is between 22 and 33 percent and it is retarded by lowering the temperature in storage; it has been entirely prevented for a year by a temperature of -10 degrees F. (14,155).

A method has been worked out for utilizing unpollinated dates of which there is occasionally some quantity. When left on the palm 2 to 4 months later than pollinated dates - until the sugar was in excess of 65 percent of the dry weight or the moisture below 50 percent of the wet weight - unpollinated khalal dates have been ripened by holding them 2 to 4 days at 125 to 135 degrees F. in high humidity. The resulting product is often somewhat fibrous and should not be used as whole fruit but it is suitable for use in date products. Subsequent ripening of unpollinated khalal dates was hastened by storage at 0 degrees F. for 3 months (159).

It is sometimes necessary to cut date bunches before all the fruit has ripened. It has been found that a larger percentage of such fruit ripens and there is less spoilage if it is left on the bunch. Freezing khalal dates at -10 degrees F. after removal from the bunch hastened subsequent

softening but the resulting quality was poor (163). Over a period of 4 years, during which there was no serious rain damage and only small differences in returns between grades, there was no gain by picking Deglet Noor fruit of relatively low quality more than twice (37).

From the comparison of climatic data with packinghouse records, it was discovered that a high percentage of dry Deglet Noor fruit has been produced when unseasonable high temperatures occurred from the middle of April to the end of May (166,167).

Some attention has been given to the problems involved in handling small lots of fruit at home or with improvised facilities and procedures have been suggested for such conditions (17,135).

TECHNICAL STUDIES

Some of the technical studies conducted at the U.S. Date Field Station do not have immediate practical application; these are made for the purpose of learning as much as possible about the structure and growth processes of the date palm. Information acquired provides a background for understanding the behavior of the date palm under varying conditions and often aids in the solution of cultural problems. It has been found that there is a critical temperature of about 50 degrees F. below which growth of the date palm stops. Some growth may occur when minimum temperatures are below this point provided maximum daily temperatures are above it (69). The fibrous structure of the date palm protects and insulates very effectively the bud and inner conducting tissue from extremes of heat and cold. Hence, the temperature of the growth center and the ascending sap current is only slightly above that of the soil in the principal root zone (70). Leaf growth is inhibited by direct sunlight (71).

The roots of many monocotyledons die back when cut but it has been found that the cut end of a date palm root may regenerate and continue growth (144).

It has been shown that the palm trunk may be induced to form roots at some distance above the normal basal root zone if it is covered with moist soil as when one is reset at a lower depth (133).

The occasional development of axillary buds of the date palm into abnormal growths, intermediate between offshoots and inflorescences but sterile and abortive, has been described (192).

It has been determined that plant food in the form of starch is stored in the trunk of the date palm. This reserve decreases during the summer and builds up during the rest of the year (10).

The nature of the structural, physiological, and chemical changes that take place during the development and ripening of the fruit are now better understood as a result of research (3,25,57,158).

A relatively low acid content (high pH value) has been found associated with high-grade dates (160). Sulfur dusting for mite control had no effect on the sulfur content of fruit. It was found that the fruit was more easily damaged by high temperatures in early summer than later (164,165).

Attempts to produce seedless fruit with chemical stimulants that have been used with some vegetable crops have not been successful with dates, but the life of the perianth ("calyx") was considerably prolonged by one of them - naphthaleneacetic acid (140).

Another growth regulator, gibberellin, applied to fruitstalks or inflorescences at any time up to and including the pollination period increased the length of the fruitstalk but also produced an undesirable spiralling. Gibberellin applied to unpollinated or pollinated fruit within a few weeks after the opening of the spathe accelerated elongation during early development. At the time of ripening, however, treated fruit was not always longer than untreated fruit and it was more susceptible to checking and to shrivel (134).

The rapid increase in dry weight and sugar content that characterizes the khalal stage has been found to occur normally only at night (29).

The effect of different environmental conditions and treatments on maturity and quality of fruit at various stages has been studied. It has been found that fruit most exposed to sunlight ripens a little ahead of the rest of the bunch, even under covers. Paper covers cause a slight retardation in ripening. There is more sunburn under brown paper covers than under white paper covers. White cold water paint is effective in reducing sunburn of fruitstalks which, in varieties like Khadrawy, is associated with severe fruit shrivel (108,142). Wax emulsion sprays applied during the khalal stage reduced shrivel but they produced an abnormally dark color and an undesirable flavor in the ripe fruit, reduced dry weight and caused somewhat later ripening (148).

In a study of 51 varieties of dates, differences in the percentage of total sugar in the dry matter of the fruit were, for the most part, too small and variable to suggest significance. However, with a few exceptions, the soft varieties contained little or no sucrose (cane sugar), the dry varieties relatively large amounts and the semi-dry varieties, intermediate amounts (23,24).

Several different chemicals have been used in unsuccessful attempts to control nutgrass, which may retard palm growth in young plantings (11).

The Fruit and Vegetable Laboratory, Western Utilization Research and Development Division, ARS, U.S.D.A., Pasadena, Calif., has recently initiated research on quality deterioration in date fruit. The reactions of the chemical constituents to different environmental conditions are being studied as a basis for improving fruit handling and date products. Already new and valuable basic information has been acquired (60,61,62,80,151,152, 173,174).

DISSEMINATION OF INFORMATION

An important part of any research program is to make the acquired information available to the industry concerned. Members of the staff of the U.S. Date Field Station frequently confer with date growers concerning specific problems and an appreciable amount of time is spent in answering correspondence relative to date culture. An effort is made to publish as soon as possible the results of research and study. Reports on specific research projects have already been listed. Information concerning cultural practices with suggestions based on experience and research have been made available to growers (106,117,135,141).

In addition, many papers summarizing experience, observations, and historical facts have been published. Often these were written because of special requests for authoritative information (1,55,63). Among the various subjects that have been covered are: The status and condition of the date industry from time to time (65,105,123,187,191,203); certain phases of the Government program relating to dates (153,185,188, 189,193,200); rainfall data (72,77); general information about the date palm (55,59,89,109,118,137,197); men who imported offshoots (110,111,122); date culture in other countries - Iraq and western Iran (34,87), Saudi Arabia (126,127), Egypt and Sudan (66,67,68,73), Libya (138), Tunisia, Algeria and Morocco (52,53,54,113,115,121,138,184,195,198), Spain (113), and Baja, California (124).

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